Application of Specialty Chemicals during Precipitation for Production of High Quality Alumina Hydrate with Higher Productivity

Ashish Rathore[1], Sirish Chandra Patnaik[2], Shivkumar DC[3] and Narayana Reddy[4]
1. Managing Director
2. Advisor
3. General Manager
4. Assistant General Manager
Kimberlite Chemicals India, Bengaluru, India
Corresponding Author: ashish@kimberliteindia.com
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Abstract

Production of Alumina hydrate by the Bayer process involves the digestion of bauxite with caustic soda and precipitation of alumina hydrate from the saturated sodium aluminate liquor. The yield and quality of precipitated alumina hydrate are significantly affected by the process parameters like precipitation temperature, residence time, seed size, solid content and alumina to soda ratio in the pregnant liquor, etc. Alumina manufacturers optimize these parameters to maximize the yield and product quality. Alumina hydrate particle size is one of the key parameters that determine the quality of metallurgical-grade alumina. A large percentage of fines, particularly below 45 microns, is undesirable for the manufacturers. Also, strength of alumina hydrate plays a major role on the breakage of particles during calcination and alumina handling. A highly efficient crystal growth modifier has been developed which can be very effective to control the fines generation and to produce much stronger particles by agglomeration and cementing the smaller particles. It also helps to control foam formation in precipitation and removes oxalate from the process. Reduction of foam can improve heat transfer efficiency, reduce scaling in precipitation, minimize tank overflow and improve operation of alumina hydrate classification systems due to reduced alumina hydrate retention in foam. In this paper laboratory tests have been conducted to evaluate effectiveness of this highly efficient crystal growth modifier on nucleation rate, particle size distribution (PSD), particles surface area, attrition index, liquor productivity and oxalate removal capacity.

Keywords: calcination, alumina quality, nucleation, agglomeration, attrition index.

1. Introduction

In the Bayer process, bauxite digested with hot caustic soda to produce saturated sodium aluminate liquor and bauxite residue as insoluble. Bauxite slurry generated in this process is treated with flocculants to separate the red mud from the pregnant liquor and this liquor is then further purified in a filtration process to remove suspended fine solids. This clear saturated aluminate liquor is then cooled and seeded with alumina hydrate to precipitate the final product, alumina hydrate. The yield and quality of precipitated alumina hydrate are significantly affected by the process parameters like precipitation temperature, residence time, seed size, solid content, caustic concentration and alumina to soda ratio in the pregnant liquor, etc.

Many research studies have been carried out to quantify the effect of process variables on the yield and strength of alumina hydrate precipitated from aluminate liquor [1, 2]. Alumina manufacturers optimize these parameters to maximize the yield and product quality. All over the world in Bayer process, there are existence of two processes for alumina hydrate precipitation technology, so called nucleation and agglomeration technology. The precipitation of alumina hydrate in both the technologies involves three mechanisms i.e. nucleation, agglomeration and crystal growth [3]. Sometime attrition is also an intermittent stage which happens due to collision of hydrate crystals or surface vessels. Size of the alumina hydrate is one of the key parameters which determines the quality of metallurgical grade alumina. The control of granulometry is linked to the relationship between the number of smaller particles below 5 microns (apparent nucleation) and the physio-chemical condition at the precipitation. Nucleation is called apparent because, in fact, it results from two well-known elementary phenomena: true nucleation –- the creation of particles around 1 to 2 microns in diameter –- and the agglomeration of fine particles less than 15 microns [4].

The success of particle size distribution control is based on the accurate measurement of fine particles in the seed hydrate. Process with higher agglomeration leads to agglomerates with numerous elementary crystals at around 20 microns and the crystals are cemented by crystal growth which corresponds to mosaic structures. These mosaic structured particles are stronger than the radial structured particles which are generated by very fine crystals around 8 microns [4–6].

Bauxite invariably contains long chain polymeric organic materials, of which content depends on its source. During digestion, these organic materials are degraded into numerous smaller species. Some of them are insoluble in nature and filter out along with red mud, whereas others are soluble and remain in the liquor. The soluble organic materials consist mainly of sodium salts of compounds with carboxylic and/or phenol functionalities, as well as a mixture of high molecular weight compounds generally referred to as humate in the Bayer process [7].

Because of this organic content of Bayer liquor, it has a natural tendency to create foam. Foaming of the liquor is aggravated by the mixing steps in the Bayer process. Foaming is especially a problem at the stage of separation of the red mud and during precipitation. The amount of pregnant liquor cannot be maximized in vessels partly filled with foam, and therefore maximum product throughput cannot be obtained. Foam also poses a safety hazard in that overflow can expose workers to high levels of caustic, which can cause severe chemical burns. Since foam is an insulator, reduction in foam can improve heat transfer efficiency. Reduction of foam can reduce scaling in precipitation and improve operation of alumina tri-hydrate classification systems due to reduced alumina tri-hydrate retention in foam [8, 9]

Oxalate in pregnant liquor is a problem which can lead to scaling problem, fine generation and formation of fragile particles [10, 11]. With continuous oxalate inputs from ongoing bauxite digestion, the concentration of sodium oxalate increases in the circulating liquor inventory until it reaches a relatively balanced concentration in the liquor.

Nowadays most of the plants use a variety of additives to control the particle size of the precipitated alumina hydrate and to reduce foam during precipitation. Scientists have developed technology to use polysaccharide or poly-saccharide graft co polymer for agglomeration and/or crystal growth promotion. The advantages of applying an aqueous emulsion comprising an alkyl or alkyl succinic anhydride have also been studied. Methods for enhancing production of alumina hydrate has been widely studied by Scientists [12–16].

Kimberlite India private Limited is a leading manufacturer of specialty chemicals for alumina industries for application as grinding aid, crystal growth modifier, foam control solution, synthetic flocculants, dewatering aid, scale inhibitor, corrosion inhibitor, humate removal, iron removal, dust suppressant and water treatment chemicals. It has developed an indigenous highly efficient crystal growth modifier, AL Flow 301 for alumina plants, which can be very effective to control both fine generation as well as reduction of foam. It is very effective to produce much stronger particles through agglomeration and cementing the smaller particles, controls foam in

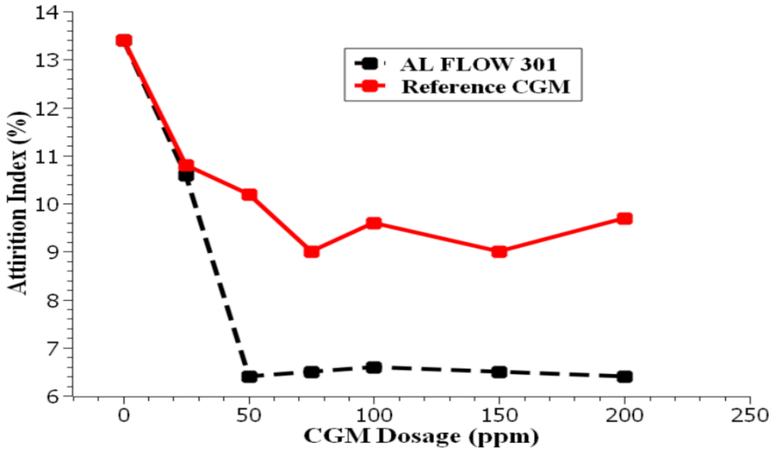

Figure 8. Effect of CGM on attrition index %.

3.7 Effect of CGM on Reduction of Foam

An anti-foam test was carried out in the laboratory to evaluate the tendency of AL Flow 301 to generate foam. According to the method, artificial foam was created in a 1000 mL glass cylinder. In another cylinder, 50 ppm of AL Flow 301 was added along with the sample, and foam was then attempted to be generated. The experiment showed that very little foam was produced, and it was unstable disappearing as soon as the airflow stopped. These results suggest that AL Flow 301 has inherent anti-foaming properties, which are highly beneficial for plant operations.

4. Conclusion

Based on the experimental results, the specialty chemical AL Flow 301, developed by Kimberlite India Private Limited, demonstrated effectiveness in reducing fines generation, promoting the precipitation of stronger crystals, and controlling soluble oxalate levels. When compared to the reference CGM, AL Flow 301 showed superior performance even at lower dosages. These findings suggest that increased plant productivity may be achieved by maintaining lower precipitation temperatures combined with the addition of smaller doses of AL Flow 301. Furthermore, due to its observed anti-foaming properties, the use of additional anti-foaming agents may be unnecessary in the precipitation process.

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6. References

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